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(54) Desmodromic valve system.

(57) Desmodromic valve system for internal combustion engines, in which the valve (7) is both positively opened and closed under the action of at least one cam (3, 4) and having means whereby the valve timing is varied with at least one engine parameter to provide timing which is close to optimum at various speeds, the means whereby the valve timing is achieved can preferably be by means of the cam(s) (3,4) having variable profiles (25, 26; 27, 28) along their length and means whereby the valve is operated by the particular profiles specifically appropriate for the speed.

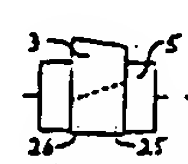


FIG.4

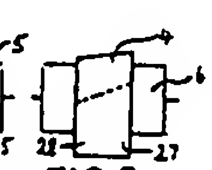
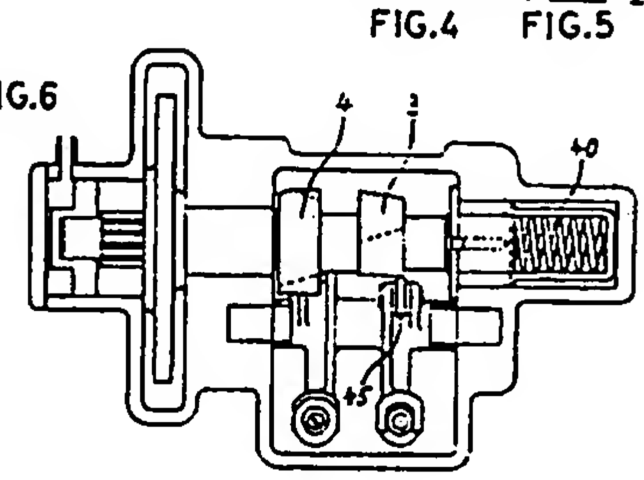


FIG.5

FIG.6



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DESMODROMIC VALVE SYSTEM

This invention relates to a desmodromic valve system for internal combustion engines and liquid or gas fuelled pumps.

The major factor which affects the power that can be developed by an internal combustion engine, whether two or four stroke, is the mass of air which can be passed through the engine and used for combustion within unit time.

Basically the limit on the number of effective cycles (r.p.m.) which can be achieved by an engine in unit time is imposed by the valve mechanism. In this specification, for simplicity, I shall refer to this parameter as speed.

Basically if a valve mechanism is arranged to operate effectively at a very high engine speed and the valve timing is adjusted to the optimum at that speed then it is found that at speeds other than the optimum the mass of air which can enter the cylinders per cycle decreases. The torque developed at engine speeds other than this optimum speed falls off from that obtainable at the optimum speed very rapidly and may only be a small percentage of the maximum torque at speed only slightly different to optimum speed. Thus such an engine, although efficient at the particular design speed, is virtually useless when operated away from the speed.

If the valve timing was adjusted to optimise torque at lower speeds then the torque decreases as the speed increases and thus no further useful power can be developed beyond a particular speed.

It will be appreciated, particularly in respect of internal combustion engines which are used in motor vehicles, that the engine must be capable of running at a wide range of engine speeds.

Thus, at low engine speeds the torque developed by the engine must be such as to be

able to readily overcome the road load, which includes a frictional component inherent in the motor vehicle design and also, possibly, a gravity component where the vehicle is working on an incline. At the same time, at high speeds, where the load increases specifically due to the incidence of wind resistance, it is necessary that good torque be available.

This situation is unsatisfactory, and it will be appreciated that it relates to effectively all internal combustion engines presently in use, as the fixed valve timing, based on the compromise between the requirements of the engine at different speeds, causes the engine to lack flexibility and it is difficult to obtain a satisfactory output throughout its speed range. In order to minimize this disadvantage either the engine capacity has to be larger than would otherwise be required or the gear box associated therewith has to be provided with a large number of relatively close ratio gears to enable the engine to continually work at or near its maximum torque condition.

It has also been found that, where the valve timing is optimised for a particular engine speed, then the major practical limitations on the engine becomes the operation of the valve return springs which provide the biassing action to close the valves each of which is opened by a push rod or cam follower operated by the cam shaft.

Once the engine speed passes the limitation of the valve springs the performance of the engine falls dramatically as the valve action becomes out of step with the engine requirements. This can also lead to engine damage as if the valves are not operating in correct timing there may be valve to valve or valve to piston collisions with dramatic results.

Another disadvantage of using spring closed valves is the loss of the power needed to be used to act against the springs to open the valves.

At maximum engine speed the percentage of power output used in opening the valves can be of the order of 3 to 4 and, it will be appreciated, this loss can be considered quite significant.

The object of the invention is to provide a valve system for internal combustion engines which overcomes these previous disadvantages.

The system, in its broad sense, comprises a desmodromic valve system in which the

valve is both positively opened and closed under the action of at least one cam and having means whereby the valve timing is varied with at least one engine parameter to provide timing which is close to optimum at various speeds and/or loads.

In a first arrangement I provide a desmodromic valve mechanism in which a cam is used to open the valve and the same or another cam is used to positively close the valve.

In one particular arrangement two cams may be provided on the same cam shaft and in a second arrangement the cams may be provided on different cam shafts each of which is in connection with a cam follower arrangement one cam causing actuation of the valve in a first direction and the other in the second direction.

The variation in valve timing is achieved by relative transverse movement between each cam and the cam follower and the cam profile is arranged so that, depending upon the speed and or torque being delivered by the engine at any time, so the valve timing is caused to change to be close to the optimum.

In order that the invention may be more readily understood it shall be described in relation to the accompanying drawings in which:-

Fig.1. is an end elevation of a first form of the valve system of the invention;

Fig.2. is an end view showing the profile of the cam which opens the valve and showing the differences in the cam profile at different positions and the angles of duration of operation of the cams;

Fig.3. is a view similar to that of Fig.2. but of the cam which closes the valve;

Fig.4. is a side elevation of the cam of Fig.2. showing the effective change in profile along the length of the cam;

Fig.5. is a view similar to that of Fig.4. but showing the cam of Fig.3.;

Fig.6. is a plan view showing a method of moving the cam in an axial direction;

Fig.7. is an end elevational view showing an alternative form of cam follower and tappet arrangement; and

Fig.8. is a view of an hydraulic system which includes means of varying the axial position of the cam.

In Fig. 1. there is shown a rocker shaft 1 carrying a rocker 2 which is provided with two cam followers 20 and 21. Two spaced cam shafts 5 and 6 carry cams 4 and 3 respectively cam 4 acting acting through the rocker 2 to close the valve 7 and cam 3 acting through the rocker 2 to open the valve 7, the rocker 2 having a tappet 22 which acts to open and close the valve.

As illustrated the valve 7 is provided with upper 8 and lower 9 contact surfaces which are acted upon by tappet 22 to cause the opening and closing of the valve 7.

The valve 7 is located in a valve guide 10 which is fixed in the cylinder head 11.

Valve seat 12 is located relative to the valve guide 10 as is conventional and the valve head 14 moving off and on seat 12 causes port 13 to open into the combustion chamber or to be isolated therefrom.

The shafts of the two cams 5 and 6 are interconnected either by gears or chains or belts so that the relative orientation between the cams are maintained on rotation of the engine and the cams are, as is conventional, driven at half crank shaft speed in a four cycle engine.

The cams 3 and 4 shown in section in Fig. 1. vary in profile along their length, as can be seen in Figs. 2 to 5. In these Figures it can be seen that the cam profiles vary from a first position at one end where the valve is open for only a relatively small part of the crank shaft movement to a position adjacent the other end where the valve is open for a substantial part of the crank shaft movement. The range of degrees of crankshaft movement generally required for the operation of the valves, suitable to a wide range of engine speeds, are indicated in Figs. 2 and 3.

The cams 3 and 4 are complementary in operation. When cam 3 is located so that the end 25 is operating the valve then the valve is opened and held open through 120 degrees of movement of the cam. At the end of this movement cam 4, which is inoperative during this period, operates to close the valve which remains closed until cam 3 commences to operate. When the cams move towards the ends 26 and 28, the

valve is open for 170 degrees of movement of the cams, which is equivalent to 340 degrees of movement of the crankshaft, and is non-operative for the rest of the rotation of the cam.

It should be noted that absolute control of the valve is only provided when the free movement of the cam followers is a minimum. Otherwise the cam followers can bounce within the range of any available movement within the constraints applied to the cam followers by the inter-relationship between the two cams.

It will be appreciated that depending upon the speed of rotation of an engine the amount of time the various valves are open for optimum results can vary substantially as can the overlap between them when the exhaust and inlet valves in any particular cylinder are open.

The cam formations, illustrated in Figs. 2 to 5, are thus exemplary only but do show the possibility of the length of the valve timing varying substantially with engine speed.

By using complex cam profiles it is possible to alter the time of opening and closing the valves vis-a-vis the rotational position of the crankshaft, that is the position of the piston in its stroke.

Fig.6 illustrates one way in which the variation in timing of the invention can be applied.

In this case the cams 3 and 4 may be on a slideably mounted cam shaft and may be held in the position illustrated by spring 40 and as the engine speed increases so the cams are moved against the spring pressure, either mechanically or hydraulically, so that, for example, the cam follower 45 contacts the cam 3 profile at axial positions along its length. The other cam follower, which is obscured in the Figure, contacts cam 4 in the complementarymanner, as previously described. In this way the required variation in the valve timing controlled by cam operation is achieved.

When the engine speed drops then the cam moves towards the illustrated position.

One manner of controlling the variation is illustrated in Fig. 8 in which pump 50 which may be an engine gear driven pump provides oil under pressure from sump 51 to chamber 52 which oil acts on piston 53 which exerts a force on shaft 54.

Provided the pressure is less than that provided by the spring 40, which is not shown in Fig. 8, the hydraulic pressure does not cause movement of shaft 54.

However as the engine speed increases, and thus the pump pressure increases, so the pressure in chamber 52 becomes greater than the spring tension and the shaft 54 moves causing axial movement of the cams.

The fluid from the pump can pass through restriction 55 at all times and as the pressure from the pump output increased so oil in the line containing the restriction 56 increases in pressure valve 57 can open permitting oil to return to the sump and by the use of one or more valves similar to valve 57 so the pressure output from the pump can be controlled to control the pressure in chamber 53 and thus the relative movement of the shaft 54 against spring 40.

Fig. 7 shows an alternative arrangement of rocker 60 which rotates about rocker shaft 61 and has cam followers 62 and 63 which are located in side by side relationship similar to that of Fig. 6 acting against lobes 64 and 65 respectively. In this case the tappet 66 is formed on the end of the rocker.

The components that determine the position of the valve relative to the tappet, and the adjustment thereof, are shown to the left on Fig. 7.

There is a lower member 67 having an upper surface against which the tappet 66 operates, which member is threaded and adapted to be screwed over the valve stem or extension thereof 72. The member 67 is held in its required position by a lock ring 70 located therebelow.

Control of the valve during its closing operation is effected by a sleeve 69 which has an internal thread which is screwed over the valve stem. This sleeve has an extension 68 which comprises the mean which actually acts against the tappet 66. The tappet 66 is similar in form to the tappet shown in Fig. 6 and terminates in a yolk so that it passes on either side of the sleeve 69.

The positive location of the sleeve 68 is effected by a grub lock screw 71 which is screwed into the sleeve and acts against the upper end of the threaded valve stem 72.

By proper adjustment of the member 67 and sleeve 69, so the tappet can be properly constrained and the valve's position when upon the seat can be correctly adjusted and

can be used to compensate for valves of different height or to take into account any variation in valve height, as would occur after the valve has been ground.

In the illustrated embodiment of Fig. 6 I have shown the cam moving relative to the cam shaft although it will be appreciated that the invention would be equally applicable to an arrangement where the rockers move relative to the cam or even to an arrangement where both the cams and rockers move one relative to the other.

Whilst the device of the present invention has been described using different forms of movement of the cam follower relative to the cam profile and different forms of positive operation of the valve it is to be appreciated that the actual embodiments are purely exemplary and the invention can be applied to any desmodromic valve system having the feature of the invention, that is that the valve timing arrangement can vary with the speed and or torque of the engine with which the arrangement is associated.

CLAIMS:

1. A desmodromic valve system in which the valve (7) is both positively opened and closed under the action of at least one cam (3, 4) and having means whereby the valve timing is varied with at least one engine parameter to provide timing which is close to optimum at various speeds and/or loads.

2. A system as claimed in claim 1 wherein the variation of the valve timing is effected by altering the profile (25, 26; 27, 28) of the cam (3, 4) as it actuates the valve, the alteration being controlled by changes in the parameter.

3. A system as claimed in claim 2 wherein the cam has a profile which varies along its length and wherein means are provided to effect relative axial movement between the cam and the cam follower.

4. A system as claimed in claim 3 wherein the cam profile is such that the time during which the valve is opened or closed varies continuously along the length of the cam.

5. A system as claimed in claim 4 wherein the relative position of initial opening or closing of the valve can vary along the length of the cam.

6. A system as claimed in any one of claims 3 to 5 wherein the cam (3, 4) is moveable relative to the valve operating means (45).

7. A system as claimed in claim 6 wherein the engine parameter is speed and/or load and wherein variation in the selected parameter(s) effect operating of means whereby the cam is caused to move.

8. A system as claimed in claim 7 wherein hydraulic means (52) are used to cause the movement of the cam.

9. A system as claimed in claim 8 wherein there is a hydraulic ram (53) associated with the valve and located in a cylinder (52), which ram is normally held biassed to a rest position by a spring or the like (40), changes in hydraulic pressure acting against the spring and effecting movement of the cam.

10. A system as claimed in any preceding claim wherein a cam (3) is used to open the valve and the same or another cam (4) is used to close the valve.

11. A system as claimed in claim 10 wherein there are two cams (64, 65), each being located on the same cam shaft, cam followers (62, 63) associated with the cams, one cam follower (62) being adapted to open the valve and the other (63) to close the valve.

12. A system as claimed in claim 10 wherein there are two cam shafts (5, 6), one (6) being adapted to operate to open the valve and the other (5) to close the valve.

13. A system as claimed in any one of claims 10 to 12 wherein means (67, 71) are provided to adjust the rest position of the valve.

14. A system as claimed in any preceding claim wherein there are a plurality of valves, each of which is operated in the same manner, the timing of the valves varying depending on the relative positions of the cylinders with which they are associated.

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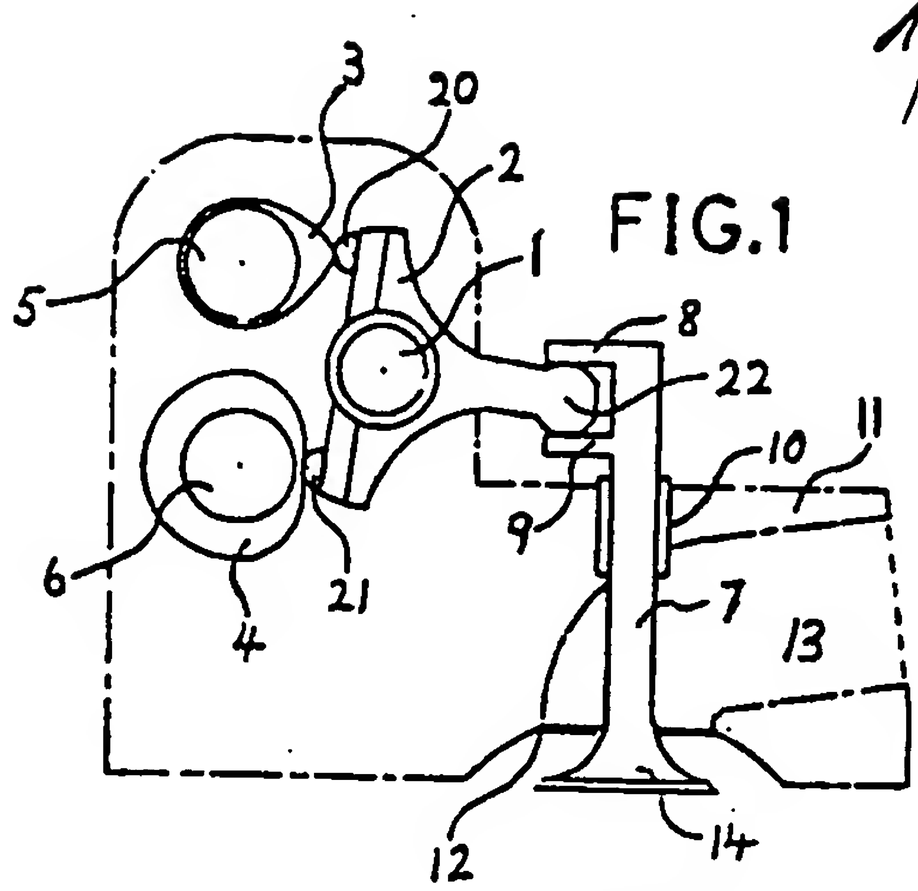


FIG.1

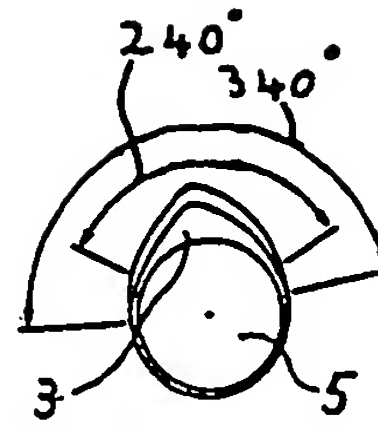


FIG.2

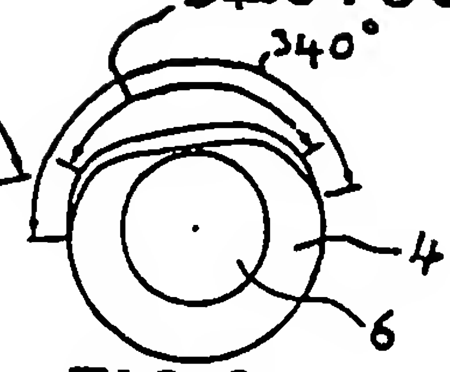


FIG.3

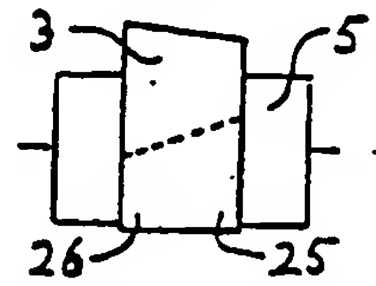


FIG.4

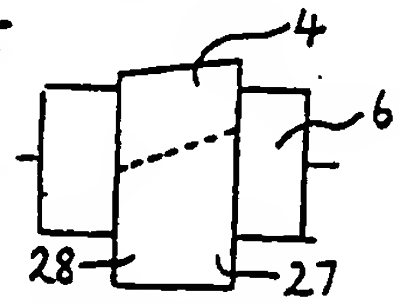


FIG.5

FIG.6

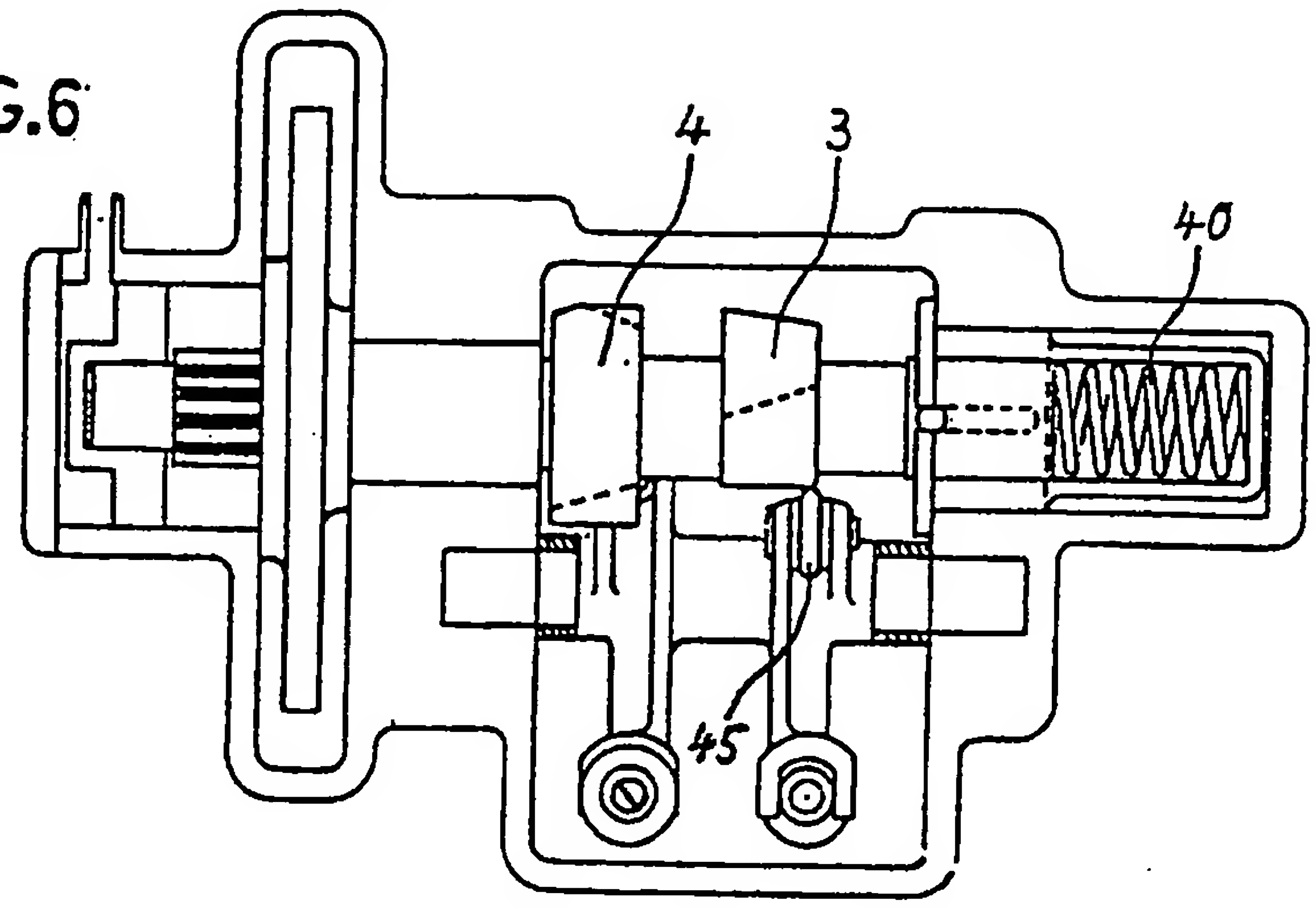
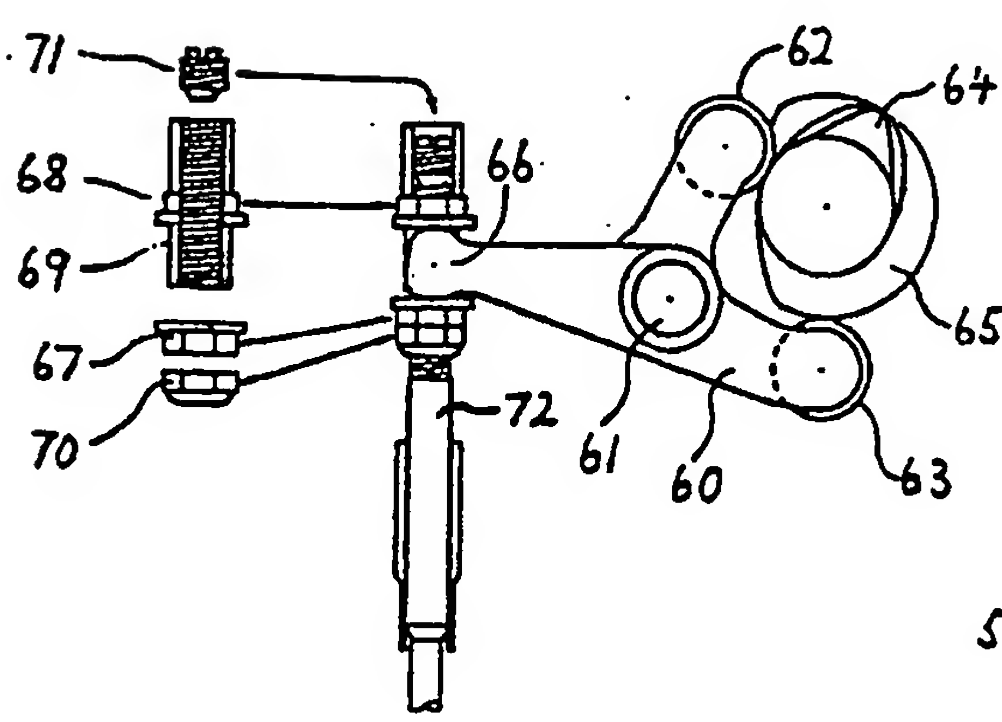


FIG.7



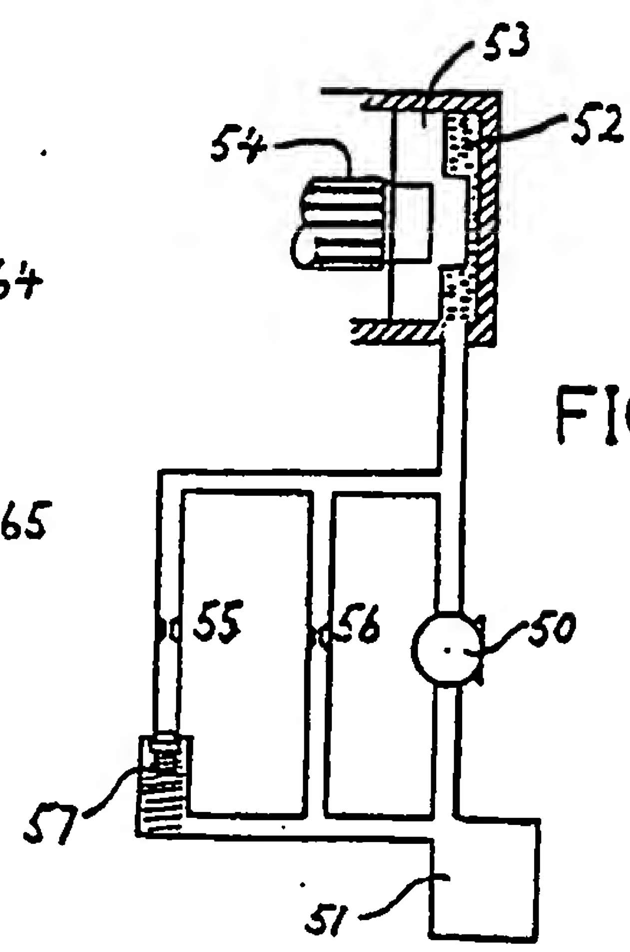


FIG.8

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EUROPEAN SEARCH REPORT

Application number

EP 83 30 1998

Category	DOCUMENTS CONSIDERED TO BE RELEVANT Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
X	DE-A-2 621 363 (DAIMLER BENZ) * Page 6, paragraphs 2-4; page 7, paragraphs 1,2 *	1,6,10,12,14	F 01 L 1/30 F 01 L 31/22
A	DE-B-1 013 115 (DAIMLER BENZ) * Column 1, lines 27-54 *	1,10	
A	DE-A-3 022 188 (HOLTMANN) * Page 5, paragraph 2 - page 8, paragraph 1 *	1,7	
A	GB-A- 127 613 (RICARDO) * Page 5, lines 25-121 *	7,9	
A	DE-A-3 025 259 (NISSAN) * Figure 2; page 12, paragraphs 2,3 *	6-9	TECHNICAL FIELDS SEARCHED (Int. Cl. 3) F 01 L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-07-1983	WASSENAAR G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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